

wherein d_1 is the inner diameter of the annular secondary light source and d_2 is the outer diameter of the annular secondary light source.

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33 ²⁷ (Twice Amended) A projection exposure apparatus comprising:
an illumination optical system disposed on an optical path of light emitted by a
light source so as to illuminate a mask, the illumination optical system including an optical
system disposed in an optical path between the light source and the mask so as to form a
variable annular illumination source, said optical system changing an annular ratio of the
variable annular illumination source; and

a projection optical system disposed in an optical path between the mask and a
substrate so as to project an image of the mask onto the substrate;

said projection exposure apparatus satisfying the following condition:

$$0.45 \leq NA_2/NA_1 \leq 0.8$$

wherein NA_1 is the numerical aperture of said projection optical system, and
 NA_2 is the numerical aperture of said illumination optical system determined by the outer
diameter of said variable annular illumination source.

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28. (Twice Amended) A projection exposure apparatus comprising:
an illumination optical system disposed in an optical path of light emitted by a
light source so as to illuminate a mask, the illumination optical system including an optical
system disposed in an optical path between the light source and the mask so as to form an
annular illumination source, said optical system changing an annular ratio of the annular
illumination source in accordance with a pattern formed on the mask; and

a projection optical system disposed in an optical path between the mask and a
substrate so as to project an image of the mask onto the substrate, said projection optical
system including a pupil defining unit disposed within the projection optical system so as to
define a pupil of the projection optical system.

47(Twice Amended) A projection exposure apparatus comprising:

an illumination optical system disposed in an optical path between a light source and a mask so as to illuminate the mask;

a projection optical system disposed in an optical path between the mask and a substrate so as to project an image of the mask onto the substrate; and

an optical system disposed within the illumination optical system so as to form one of a circular secondary light source and an annular secondary light source selectively based on light from the light source, the optical system changing a size of the circular secondary light source and changing an annular ratio of the annular secondary light source.

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(Amended) An apparatus according to claim 26, wherein said optical system includes an optical integrator and an optical element having a conical surface, disposed between said first light source and the optical integrator.

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(Amended) An apparatus according to claim 26, wherein said optical system satisfies the following condition:

$$0.45 \leq NA_2/NA_1 \leq 0.8$$

wherein NA_1 is the numerical aperture of said projection optical system, and NA_2 is the numerical aperture of said illumination optical system determined by the outer diameter of said annular secondary light source.

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(Amended) An apparatus according to claim 27, wherein said optical system changes the annular ratio of said annular illumination source in accordance with a pattern on said mask.

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(Amended) An apparatus according to claim 25, wherein said optical system includes a plurality of annular stops having annular ratios that are different from each other, one of the plurality of annular stops selected in accordance with said pattern being disposed on said optical path.

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97. (Amended) A projection exposure apparatus comprising:
an illumination optical system in which an internal reflection type integrator is
disposed on an optical axis to illuminate a mask with light from a light source passing
through the internal reflection type integrator; and
a projection optical system through which light from the mask passes;
said illumination optical system including an optical device disposed on the
optical axis to form a light intensity distribution having a substantially annular shape on a
pupil plane of the illumination optical system, the optical device being capable of changing at
least one of the annular ratio, the outer diameter, and the inner diameter of the light intensity
distribution in accordance with a pattern on the mask.

Please add the following claims 98-132:

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30 --98. (New) An apparatus according to claim 26, wherein said optical system
comprises a plurality of annular stops having annular ratios that are different from each other
so as to set one of said plurality of annular stops in an optical path selectively.--

31 --99. (New) An apparatus according to claim 26, wherein said optical system
comprises a first optical element with a first conical surface, a second optical element with a
second conical surface and a variable distance between said first optical element and said
second optical element so as to change an annular ratio with respect to the annular secondary
light source.--

32 --100. (New) An apparatus according to claim 99, wherein said optical system
further comprises an optical integrator disposed in an optical path between said second optical
element and the mask.--

37 --101. (New) An apparatus according to claim 27, wherein said optical system
comprises a first optical element with a first conical surface, a second optical element with a
second conical surface and a variable distance between said first optical element and said

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second optical element so as to change an annular ratio with respect to the variable annular illumination source.--

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--102. (New) An apparatus according to claim 101, wherein said optical system further comprises an optical integrator disposed in an optical path between said second optical element and the mask.--

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--103. (New) A projection exposure apparatus comprising:

an illumination optical system that illuminates a mask and comprising a light source including an excimer laser, and an optical system disposed in an optical path formed by the light source so as to form an annular secondary light source having a light intensity distribution with a substantially annular shape on a pupil of the illumination optical system and an deflection member disposed in an optical path between said light source and said optical system; and

a projection optical system disposed in an optical path between the mask and a substrate so as to project an image of the mask onto the substrate;

wherein said optical system changes an annular ratio with respect to the light intensity distribution.--

--104. (New) An apparatus according to claim 103, further comprising:

an optical integrator disposed in an optical path between said optical system and the mask, said optical integrator including a fly-eye type integrator or an internal reflection type integrator.--

--105. (New) An apparatus according to claim 103, further comprising a pupil changing unit disposed within said projection optical system so as to define a pupil of said projection optical system and change a numerical aperture of said projection optical system.--

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--106. (New) An apparatus according to claim 105, wherein said optical system includes a first optical element with a first conical surface that is disposed in an optical path between the light source and the mask, a second optical element with a second conical surface

that is disposed in the optical path between said first optical element and the mask, and a variable distance between said first optical element and said second optical element so as to change the annular ratio with respect to the light intensity distribution.--

67 ~~-107~~ (New) An apparatus according to claim 106, further comprising a pupil changing unit disposed within said projection optical system so as to define a pupil of said projection optical system and change a numerical aperture of said projection optical system.--

68 ~~-108~~ (New) An apparatus according to claim 106, wherein said optical system further comprises an optical integrator disposed in an optical path between said second optical element and the mask.--

69 ~~-109~~ (New) An apparatus according to claim 103, wherein said illumination optical system satisfies the following condition:

$$\frac{1}{3} \leq d_1/d_2 \leq \frac{2}{3}$$

where d_1 is the inner diameter of the annular secondary light source and d_2 is the outer diameter of the annular secondary light source.--

70 ~~-110~~ (New) An apparatus according to claim 103, wherein said optical system changes the annular ratio with respect to the annular secondary light source under a high illumination efficiency.--

71 ~~-111~~ (New) An apparatus according to claim 110, wherein said optical system includes a first optical element with a first conical surface that is disposed in an optical path between the light source and the mask, a second optical element with a second conical surface that is disposed in the optical path between said first optical element and the mask, and a variable distance between said first optical element and said second optical element so as to change the annular ratio with respect to the light intensity distribution.--

72 ~~-112~~ (New) An apparatus according to claim 111, wherein said optical system further comprises an optical integrator disposed in an optical path between said second optical element and the mask.--

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--113. (New) A projection exposure apparatus comprising:

an illumination optical system disposed in an optical path of light emitted by a light source so as to illuminate a mask, said illumination optical system including an optical system disposed in an optical path between the light source and the mask so as to form a variable annular illumination source, said optical system changing an annular ratio with respect to the annular illumination source; and

a projection optical system disposed in an optical path between the mask and a substrate so as to project an image of the mask onto the substrate, said projection optical system including a pupil defining unit disposed within said projection optical system so as to define a pupil of said projection optical system.--

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76 --114. (New) An apparatus according to claim 113, wherein said optical system changes the annular ratio with respect to the annular illumination source under a high illumination efficiency.--

77 --115. (New) An apparatus according to claim 114, wherein said optical system comprises a first optical element with a first conical surface that is disposed in an optical path between the light source and the mask, a second optical element with a second conical surface that is disposed in the optical path between said first optical element and the mask, and a variable distance between said first optical element and said second optical element so as to change the annular ratio with respect to the annular illumination source.--

78 --116. (New) An apparatus according to claim 115, wherein said optical system further comprises an optical integrator disposed in an optical path between said second optical element and the mask.--

79 --117. (New) An apparatus according to claim 114, wherein said pupil defining unit comprises an aperture stop unit changing the pupil of said projection optical system.--

80 --118. (New) An apparatus according to claim 117, wherein said aperture stop unit comprises a variable aperture stop.--

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--119. (New) An apparatus according to claim 114, wherein said projection optical system has a numerical aperture not less than 0.4 at a side of the substrate.--

--120. (New) An apparatus according to claim 28, wherein said pupil defining unit comprises an aperture stop unit changing the pupil of said projection optical system.--

--121. (New) An apparatus according to claim 120, wherein said aperture stop unit comprising a variable aperture stop.--

--122. (New) An apparatus according to claim 121, wherein said projection optical system has a numerical aperture not less than 0.4 at a side of the substrate.--

--123. (New) An apparatus according to claim 28, wherein said optical system comprises an optical integrator and an aperture stop unit disposed in an optical path between said optical integrator and the mask, the aperture stop unit includes a circular opening and an annular opening so as to selectively form one of a circular illumination source and the annular illumination source.--

--124. (New) An apparatus according to claim 28, wherein said optical system changes the annular ratio with respect to the annular illumination source under a high illumination efficiency.--

45 --125. (New) An apparatus according to claim 124, wherein said optical system comprises a first optical element with a first conical surface that is disposed in an optical path between the light source and the mask, a second optical element with a second conical surface that is disposed in the optical path between said first optical element and the mask, and a variable distance between said first optical element and said second optical element so as to change an annular ratio with respect to the annular illumination source.--

46 --126. (New) An apparatus according to claim 125, wherein said optical system further comprises an optical integrator disposed in an optical path between said second optical element and the mask.--

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--127. (New) An apparatus according to claim 29, wherein said optical system comprises an optical integrator and an aperture stop disposed in an optical path between the optical integrator and the mask, the aperture stop unit includes a circular opening and an annular opening so as to selectively form one of the circular secondary light source and the annular secondary light source.--

--128. (New) An apparatus according to claim 29, wherein said optical system comprises a first optical element with a first conical surface that is disposed in an optical path between the light source and the mask, a second optical element with a second conical surface that is disposed in the optical path between said first optical element and the mask, and a variable distance between said first optical element and said second optical element so as to change the annular ratio with respect to the annular secondary light source.--

54 --129. (New) An apparatus according to claim 97, wherein said optical device comprises a plurality of annular stops having annular ratios that are different from each other so as to set one of said plurality of annular stops in an optical path selectively.--

55 --130. (New) An apparatus according to claim 97, wherein said optical device changes the annular ratio with respect to the light intensity distribution under a high illumination efficiency.--

56 --131. (New) An apparatus according to claim 130, wherein said optical device comprises a first optical element with a first conical surface, a second optical element with a second conical surface and a variable distance between said first optical element and said second optical element so as to change the annular ratio.--

57 --132. (New) An apparatus according to claim 131, wherein said optical device further comprises an optical integrator disposed between said second optical element and the mask.--